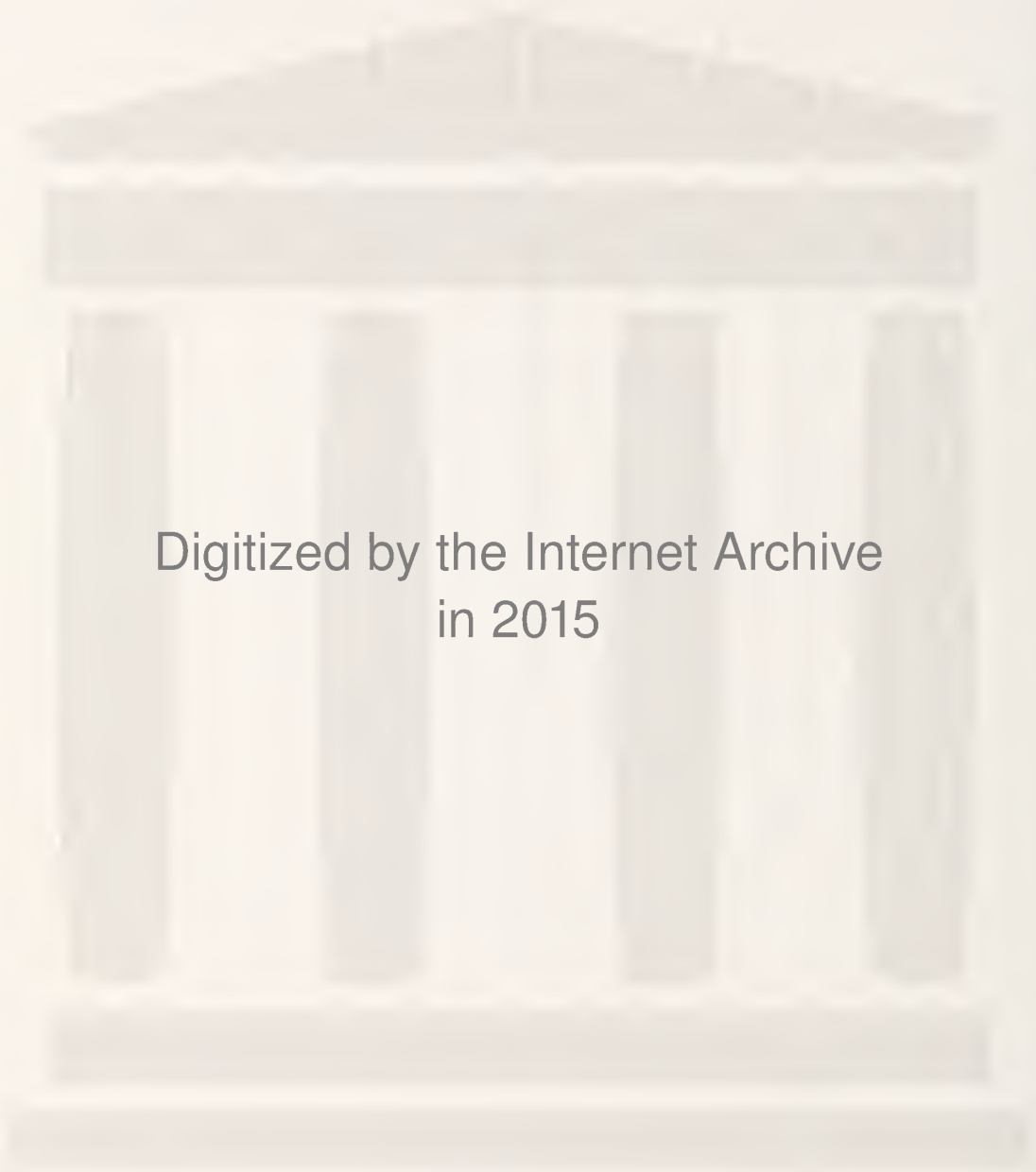
ANNUAL REPORT



Maryland Agricultural Experiment Station

1981 Annual Report

University of Maryland
College Park Eastern Shore

From the Director:

The achievements of agriculture in this country are overwhelming. Crop production per acre has increased by one-half since 1950, and farm labor productivity doubled in the same period. Today's farm worker provides enough high-quality, inexpensive food for himself and 70 others, some of whom live abroad. Here in Maryland, increased crop and animal production has been the rule rather than the exception.

Equally impressive is the economic importance of agriculture in this country. Agriculture is responsible for 25 percent of the Gross National Product and employs 17 to 20 million people. The $41 billion worth of agricultural exports in 1981 was a welcome boost to our national trade deficit. Here in Maryland, on-farm cash receipts amounted to almost $1 billion and–when coupled with such off-farm activities as processing, and wholesale and retail trade–comprise what our governor has called "Maryland's number-one industry."

How has agriculture attained this level of importance? Part of the answer is agricultural research. For over a century the federal-state agricultural research system has opened the door for breakthroughs which have ranged from hybrid corn to artificial insemination in animals to penicillin. History has indicated that each dollar invested in agricultural research will eventually return $4 to the national economy.

Perhaps agriculture and its related research and Extension efforts have done their collective job too well and too quietly. For now, amidst such pressures as "urban sprawl," rising production costs and food demands, agricultural research is not receiving the support it deserves and needs. Shortages of dollars for research now will adversely affect agricultural growth in the future. In light of agriculture's importance both on and off the farm, can any of us afford this?

I invite you to read this report about some of our research activities. Our objectives are two-fold: To solve today's problems through applied research and to tackle tomorrow's challenges with a solid data base developed through basic research. Since 1888, the Maryland Agricultural Experiment Station has developed a proud tradition as a supplier of technology which has supported and boosted Maryland agriculture. With your help, we will continue in this mission for Maryland's 3,000 producers and 4 million consumers.

W. Lamar Harris

W. Lamar Harris
Director
Maryland Agricultural Experiment Station

Natural Resources and Forestry

Agricultural research has a tradition devoted to the development of knowledge enabling producers and consumers to conserve and manage natural resources wisely. Research scientists with the Maryland Agricultural Experiment Station are engaged in studies designed to maintain Maryland's farmland and forest resources, manage potential waste problems and direct the development of new resources.

Managing Resources, Increasing Productivity

Since the dawn of agrarian history, land and water have been the basic building blocks of successful agriculture. Increasing agricultural productivity responsibly and managing these two vital resources through a basic understanding of their interaction with other resources are parts of the research effort.

No-tillage cultivation methods–involving planting with minimum soil disturbance into some type of crop residue–are gaining popularity in Maryland.

Agronomists' studies of fertilizer effects on conventional and no-till crops in Maryland, and the effects of those crops on the physical characteristics of soil, attempt to answer some of agricultural science's questions about resource interaction. Researchers have found, for example, that no-tillage practices produce virtually the same yields as conventional-tillage practices, without the added expense of increasing fertilizer application. When applied, however, extra fertilizer has shown marked yield improvement and, based on figures supplied by Maryland corn farmers, no-till continues to out-yield conventional-tillage. In addition, studies show no-till exhibits special properties during periods of drought. High fertilizer application rates during drought in conventional-tilled fields produced crops exhibiting burn, while high fertilizer rates in no-till produced fewer negative side effects.

As a result of these no-till studies, researchers have made other discoveries that will allow Extension specialists to make specific recommendations to farmers on fertilizer application. Experimenting with different types of nitrogen, for example, they have found that the most concentrated form is not always the best: When not incorporated into the soil, highly concentrated forms of nitrogen can be lost to the atmosphere, diluting any benefits concentration may have produced. In addition, researchers discovered that splitting nitrogen applications under no-till cultivation produced higher yields under experimental conditions, even in soils previously considered unsuitable for corn and soybean production.

Water resources have come under the scrutiny of researchers with their studies of watersheds, drainage basins and related land use. One area receiving considerable attention is agricultural engineers' use of computer models of all these interrelated phenomena. A relatively new process, computer simulation in hydrology, enables researchers to construct from field data informative models of watersheds, without leaving the computer laboratory. Thanks to high speed digital computers, such problems as pollution and water management are now being studied in more detail without endangering or disturbing the actual test subject.

Ecological Studies

Humankind, prodigious in its consumption of natural resources, also is prodigious in the amount of waste it creates. Research continues to address the question: How best can we handle our waste materials?

Studies exploring composted municipal waste as portions of growing material for forest stands, nursery seedling production and production of vegetable transplants are part of the research effort. Forests, in particular, may offer significant opportunities for disposal of treated waste because researchers find there is less concern there for heavy metal accumulation and disease-causing pathogens.

Nonpoint source pollution continues to be a concern to Maryland agriculture. A number of research efforts have been mounted in this important area and the work has been expanded to include evaluation of forest systems in the state as a possible source of nonpoint pollution.

Additional research efforts continue in areas to determine possible effects of herbicide runoff on the ecosystems of such bodies of water as the Chesapeake Bay. Scientists have made determinations about herbicide concentrations in the Wye River, a Bay tributary. Findings from one study show herbicide concentrations in the top 3 inches of soil drop drastically during the warm weather growing season and are not detectable by early winter. This, say researchers, indicates that the danger of herbicide leaching

is highest immediately after application but diminishes rapidly soon thereafter. In another study, researchers' measurements show a herbicide concentration in the Wye River of three parts per billion, or an equivalent 3 pounds in the entire 270-acre tributary area. Say scientists, this figure is so low that any damage to the water in the Wye River attributable to herbicide concentration is most unlikely.

Research continues, as well, on utilization of materials once considered waste that scientists now believe may be used as alternatives for other, increasingly scarce resources.

Nitrogen, for example, has become an important fertilizer as population and, thus, world food demands increase. Past studies have shown its beneficial effects on crop production, but nitrogen has fast become expensive to manufacture, buy and apply. Scientists, therefore, have searched for alternative nitrogen sources that offer its proven benefits, but at a reduced cost to the farmer. Their studies have shown promising results using such alternative nitrogen sources as poultry processing plant waste.

Case Study–Gypsy Moth

Mention the words "gypsy moth" and they are likely to evoke a series of groans from New England to south of Maryland. Gypsy moths have done more to strip whole forests of their foliage wardrobe than any other single insect pest in the United States. And, although there is visible evidence of the damage their voracious appetites inflict, no one is certain exactly how much the gypsy moth costs us each year in terms of stripped, lost or crippled trees. Some estimates place wood loss damages alone caused by defoliation at two to three cords per acre per year. That estimate, does not address aesthetic damages.

The only absolutes, most experts agree, are how gypsy moths got here, and that they are probably here to stay. Total eradication is virtually impossible and the best approach is to assemble a number of weapons, to be used singly or in concert under specified conditions.

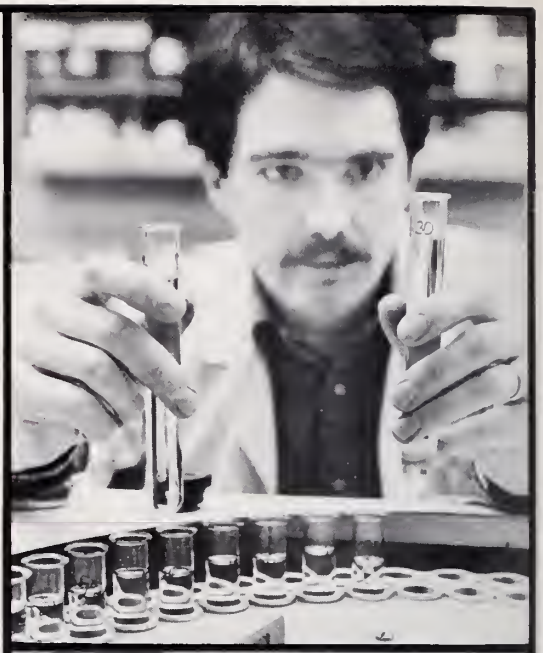
Scientists are concentrating on a number of approaches to gypsy moth control. Most of these studies stress biological and cultural–in addition to chemical–means of control and range from basic to applied research methods.

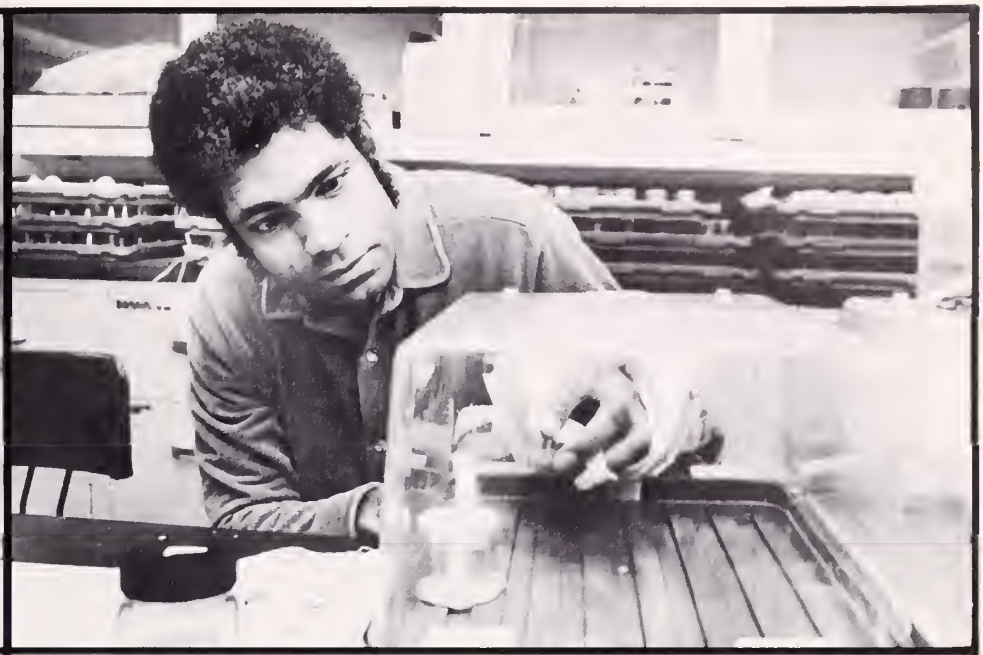
As part of basic research, entomologists are examining the gypsy moth's diet to determine how changes in its eating habits will change the gypsy moth itself. They have discovered, for example, that as the gypsy moth has moved south, its diet has changed from the oak and hickory hardwoods of the Northeast United States to the softer pine varieties of Maryland and points south. Monitoring studies are helping researchers to determine how the change in diet will affect the gypsy moth's ability to reproduce, its body size, its dispersal behavior and palatability to natural enemies as this population surge continues southward.

Entomologists also have discovered that gypsy moths show different dietary preferences at different stages in their physical development. Under certain circumstances gypsy moths will not feed on some species of trees immediately after hatching, but will change their feeding patterns later as they mature. Scientists hypothesize that mixed diets from several species of trees may be responsible for more gypsy moth outbreaks than limited diets from only one tree species.

Additionally, researchers continue work with the promising approach of using the gypsy moth's natural enemies as a means of control. Their investigation focuses on a broad array of studies within this single approach and ranges from the study of natural enemy biology and ecology to questions about natural enemy effectiveness. For example, some of their biological studies will yield useful information to those who must make a choice between using enemies occurring in the moth's natural environment or those mass-reared in laboratories. On the other hand, problematic studies investigate why the effectiveness of natural enemies is so variable from one area of the country to another. Researchers reason that the gypsy moth's change in diet from one part of the country to another has a significant effect on the ability of its natural enemies to thrive, reproduce and destroy moth populations.

Finally, researchers are making significant headway in new studies of the gypsy moth's eclosion process–that point in its adult lifecycle when it emerges from the pupal case. These studies may give science some clues on how best to "turn off" adult behavior such as reproduction and flight as well as more destructive forms of behavior. The key, they have found, is a hormone in the moth's brain that triggers eclosion as well as these other types of adult behavior. Understanding that release mechanism should offer researchers an opportunity to interfere with adult behavior which, in turn, may help control the population spread of the gypsy moth.





Land, air, water... They are principal resources essential to successful agriculture. Their conditions directly affect other resources like forests, soil quality and the aesthetic value of our environment.

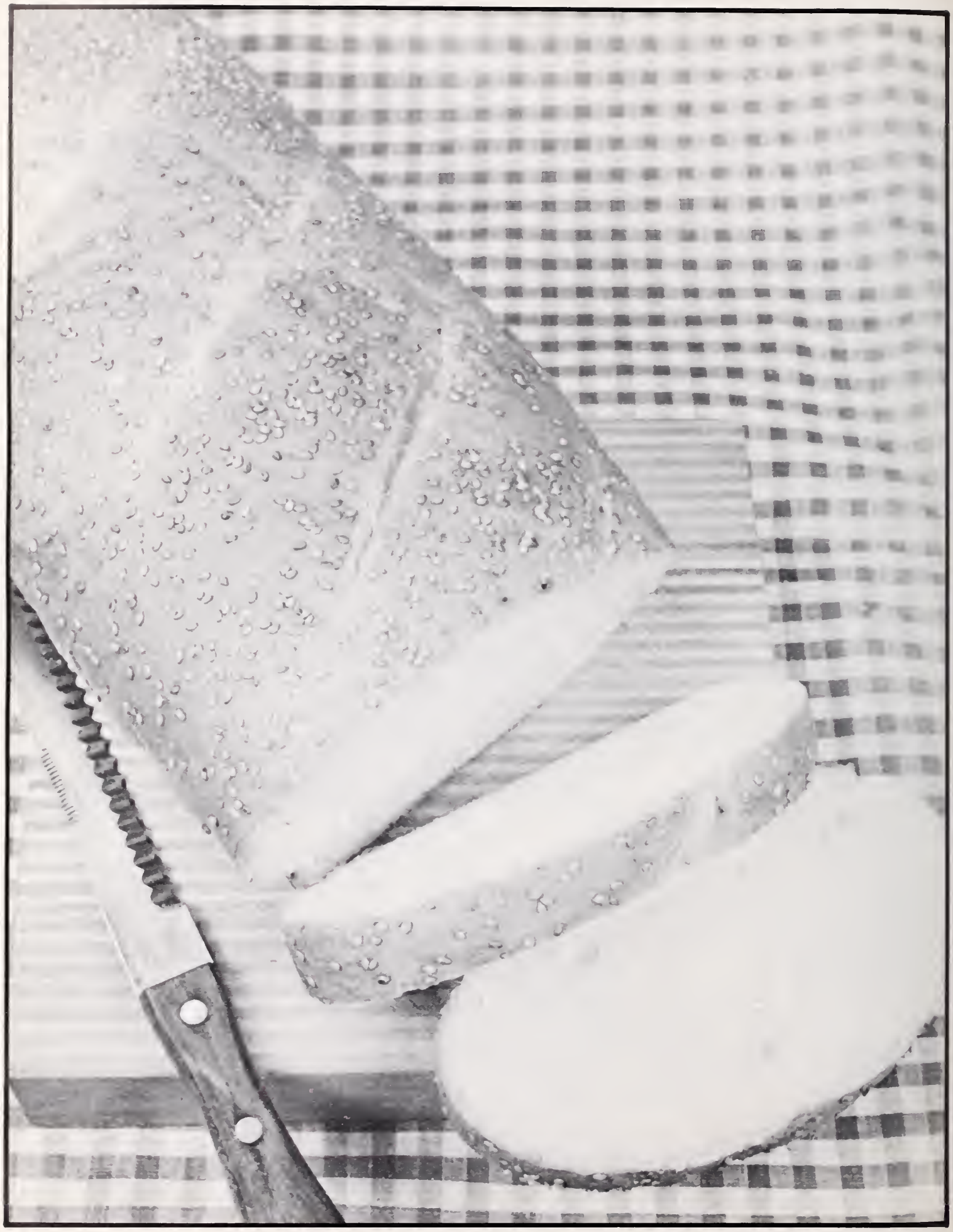
Top left—Nitrogen is an increasingly precious resource as fertilizer in agricultural use. Here an agronomist tests nitrogen content of plants cultivated under no-tillage methods.

Bottom left—Agricultural engineers have developed computer simulations of land and water resources, allowing scientists to study these subjects without leaving the laboratory or interfering with the environment.

Above—Parasitic wasps are studied by entomologists as one of several biological controls of the voracious gypsy moth.

Right—The adult gypsy moth is responsible for more tree defoliation in the U.S. Northeast than any other insect pest.

Top right–Entomologists have found gypsy moth parasites mass-reared in the laboratory are inferior to their field counterparts. Their research indicates some of the reasons may be due to chemical compounds in the food plants gypsy moths consume which are carried in the pests' tissues.



Plants and Crops

Crop production in Maryland continues to be an important segment of agriculture's contribution to the state economy, ranking second in agricultural cash receipts only to dairy and poultry. Research efforts to improve crop production comprise a significant portion of experimental studies.

Integrated Pest Management

Agriculture experts estimate nearly half of the world's potential crop production is eaten by insect pests. Sole reliance on chemical control has proven to be a major problem for modern agriculture because, in placing most of its emphasis on chemical control, the industry in recent years has faced increased resistance to pesticides by some pests, chemical residues in food and the environment, and the unintentional destruction of beneficial insects.

Although the use of chemicals is still considered an important means of control, researchers now have integrated chemical control into a total, coordinated program that emphasizes a natural course of action whenever possible. Integrated Pest Management (IPM) programs are recognized generally by science as a valuable, comprehensive tool using biological and cultural, in addition to chemical, means of curtailing economic loss from pests.

Scientists here continue the search for nonchemical methods of insect control, concentrating specifically on identifying microbial agents–viruses unique to certain harmful insects–that may serve as biological and self-sustaining means of pest control. Their studies cover not only the major field crops indigenous to Maryland but include increasingly important orchard, vineyard and vegetable crops. They have discovered that with increased potential for yield come increased hazards from pest infestation.

Their continued work on new, safe, synthetic insecticides to replace those removed from the marketplace constitutes the chemical leg of the IPM triad and holds great promise for crop and fruit growers of Maryland.

Moreover, they have shown the IPM philosophy involves more than the ammunition of a three-pronged attack on insect pests. It also involves the attack's strategy. Entomologists have completed a comprehensive study that, as a model, will help train individuals in the state to give modern, well-informed advice to farmers on the use and monitoring of all aspects of an IPM scheme. Armed with this model, a battery of personnel can answer previously elusive questions brought to them by farmers such as "Where is the cutoff between economic losses and what I can expect to invest in IPM schemes?" and "What is the best IPM technique for my particular crop, climate and time of year?"

With the use of any IPM technique–especially those involving chemical substances–comes responsibility. Thus, researchers have continued studies relating to pesticide residues on and near Maryland's agricultural lands. Work also continues on the possible effects of pesticides on nontargeted "friendly" organisms. This includes the study of beneficial insects and investigation of the potential impact of farm herbicides on aquatic plantlife such as that in the Chesapeake Bay.

An example of research's success with pest management involves "Blueboy," a wheat variety snubbed by Maryland farmers and researchers 5 years ago. As a result of research, "Blueboy" may make a reappearance after posting an unheard-of harvest of more than 100 bushels per acre under experimental conditions. Once promising, "Blueboy" was purged from Maryland's recommended list of wheat varieties for farmers after researchers found they could not cope with its extreme susceptibility to the fungus pest powdery mildew. But after scientists experimented with combinations of fungicides and heavy doses of nitrogen fertilizer, "Blueboy" offered harvests of up to 105 bushels per acre, a 50 percent increase over its normal rate of productivity 5 years ago. Now researchers believe they can expand the principles they developed with "Blueboy" to encompass other cash crops such as soybeans where they hope to find another harvest success.

Production Studies

Research here has enjoyed success in the development of new crop varieties. An indication of this success is exemplified by a high acceptance level among Maryland farmers of new varieties developed by plant breeders.

Tobacco, for example, is one of the major success stories. By 1981, Maryland tobacco farmers were planting at least 98 percent of their fields with tobacco varieties developed and released by Experiment Station breeders.

Researchers made two major crop releases in 1981. Long-term genetic development and testing resulted in the release of a new tobacco variety–Maryland 341–for local farmers that promises high wildfire and mosaic resistance. It was the second tobacco variety jointly released by the Maryland Agricultural Experiment Station and the U.S. Department of Agriculture developed specifically for those plant diseases. Meeting high quality and yield criteria established by researchers, Maryland 341 has attracted interest from European concerns which have found the variety acceptable for the two essential tobacco quality tests of smoke and aroma. Like Maryland 341, several years of experimental research went into the development of "Severn," a new hardy wheat variety and the second released by Maryland scientists in the last 5 years. "Severn" should prove to be popular among Maryland farmers who double-crop soybeans and wheat, say researchers, because of the variety's early maturity date. Its development marks a substantial improvement of approximately 7 bushels per acre over its closest commercial competitor and offers early maturity, excellent baking quality and high disease resistance. Tests showed "Severn" headed over a 6-year period in Maryland on or about May 12. East of the Chesapeake Bay, "Severn" shows a slightly earlier heading date and somewhat higher winter survival rate than the 93 percent produced under test conditions.

Ornamental Studies

Maryland's wholesale potted and cut flower industry is a multi-million dollar a year business and researchers note that by the end of this century, its annual value may be worth more than $22 million.

Recognizing its importance to Maryland, horticulturists have contributed to a number of studies to improve production methods and meet the demand of the buying public. Studies include production schedules to increase yields, new plant materials and plant types to improve quality and resistance to disease, efforts to stimulate longer blooming periods for floral varieties, and attempts to prolong the post-harvest life of cut flowers.

Specific examples include scientists' study of extending the post-harvest decorative life of such popular flowers as zinnias, roses, carnations and chrysanthemums. After they determined the critical balance of common sucrose and a floral preservative called 8-HQC as a holding solution, researchers found they could extend the decorative life of these valuable flowers to 22 days.

Another example is work dealing with extending growing seasons of highly popular flowering plants. Hydrangeas have been successful subjects in experimentation by horticulturists who found several methods to "force" the plant's growing season beyond the traditional Easter to Mother's Day period to nearly year round. One method considered by researchers to be most feasible involved cultivation in the usual manner prescribed by commercial growers, but differed in its use of early propagation and chemical growth regulators to induce early flower formation.

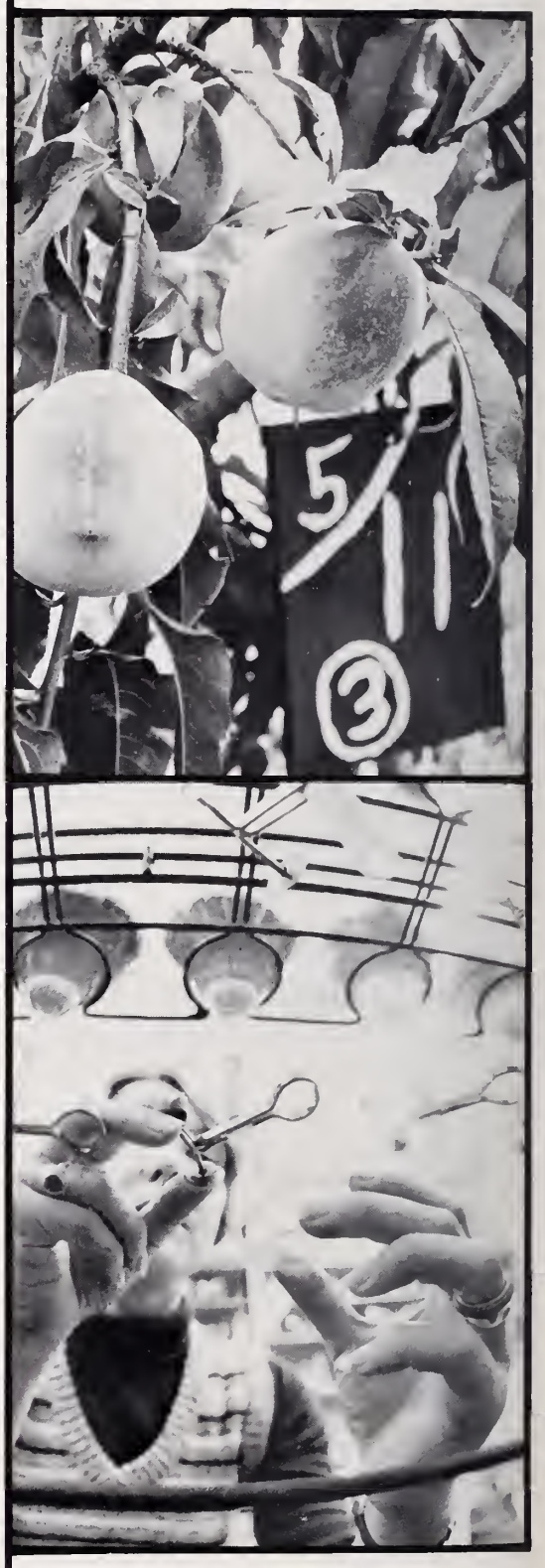
Poinsettias, too, are an example of successful experimentation by researchers who have established environmental controls, cultural needs and nutritional requirements of this flowering potted plant. The results of these studies, in turn, have allowed researchers to establish growing schedules that help poinsettia producers develop high quality plants to specific market demands. An integral part of this research has been the development of proper use and timing of chemicals for regulating growth and flowering. These practices have resulted in plants of high quality and lasting value for consumers.

Postharvest Studies

Research's commitment to agriculture does not end with the harvest. Maryland researchers have made significant contributions to producers and consumers in their studies of crops after harvest.

Horticulturists, for example, have undertaken major studies of controlled atmosphere techniques to prolong the storage life of fruits, vegetables and flowers. This relatively new area of research–one in which Maryland scientists have made important contributions–has shown that apples, potatoes, pears, bananas and certain types of cut flowers can be stored in a controlled atmosphere of gas such as carbon dioxide for extended periods of time without a significant loss of quality or nutritional value. They have found, also, that controlled atmosphere storage of these items represents a savings in energy costs over other conventional methods of storage.

Their studies also seek new methods to delay the process of fruit and vegetable decay immediately after harvest. Building upon research that showed pathogenic organisms could be controlled with the nontoxic chemical compound acetaldehyde, they have studied its use under lower pressure and temperature rates to determine if the method is compatible with commercial application.



Case Study–Nematodes

Nearly all soils cultivated by man contain species of plant parasitic animals that can reduce crop yields, but none poses for the researcher a detective's dilemma like nematodes.

The nematode problem is perplexing because nematodes are difficult to detect and identify. Botanists have found complex similarities between plant damage caused by fungi and bacteria, for example, and that caused by certain species of nematodes.

Poor plant growth also may result from conditions that have no relation to nematode damage such as differing soil types, flooding, drought, pesticide toxicity and inadequate levels of plant nutrients, thus making nematode detection and identification as primary pathogens additionally difficult.

But something happened in early 1981 to momentarily divert researchers from their scheduled course of general nematode study when they were alerted to a disconcerting piece of news: Maryland researchers found the corn cyst nematode on Maryland's Eastern Shore. Previously known only in the Middle and Near East, it has destroyed a significant portion of the corn crop in Egypt, Pakistan and India.

Perhaps no one will ever know how the corn cyst nematode got here in the first place, and botanists turned their immediate attention instead to determine how widespread infestation is on the upper Delmarva Peninsula. Harvest yields from the initially affected farm are being analyzed and researchers–working in cooperation with state and federal agencies–plan to move out to surrounding acreage to determine if it, too, is infested.

Questions still unanswered for researchers and Maryland agriculture include: How serious a pathogen is the corn cyst nematode on corn here in this country; does it cut yields as drastically here as in other countries where it has been detected; how much of an economic threat does it pose to U.S. corn farmers?

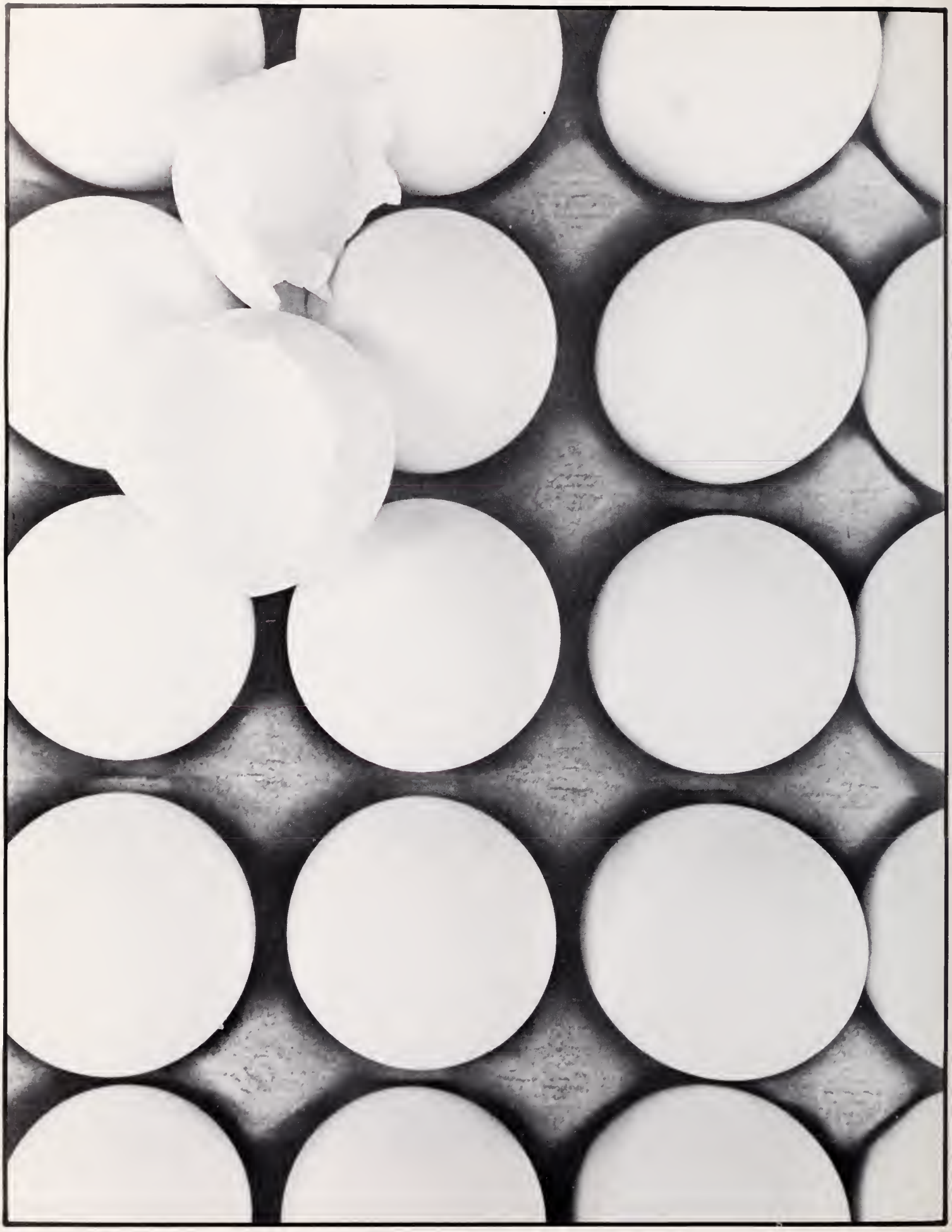
Some of these questions may be answered as researchers analyze yield data from 1981 tests.

Bread, the staff of life... Consumers benefit from the development and release by Maryland researchers of new wheat varieties. Joining this crop improvement research are Maryland's big three in agronomy: Corn, soybeans and tobacco.

***Top left*—Peaches like these, shown at the Sharpsburg Research and Education Center, are examples of fruit variety improvement studies carried on by horticulturists.**

***Top right*—Soybeans growing in barley stubble in Queen Anne's county demonstrate the increasing popularity of no-tillage cultivation methods under investigation by agronomists at the nearby Wye Research Center.**

***Bottom left and right*—The soybean cyst nematode (enlarged by microphotography) is the subject of intense study by researchers who are broadening science's basic understanding of this crop pest. Botanists, meanwhile, are turning increased attention to the corn cyst nematode, blamed for extensive damage to corn crops in Egypt, India and Pakistan and discovered in the United States in 1981 in Maryland's Kent county.**



Animals and Poultry

Livestock, poultry and dairy production remained Maryland agriculture's number one contributor to cash receipts in 1980. Clearly, with the economic value of dairy, livestock and poultry in Maryland, their health, reproductive vigor, genetic improvement, quality and yield are of vital concern to research and the state's agricultural producers.

Animal Health

Veterinary scientists continue their pursuit of animal health and disease prevention information, gleaned from a variety of studies with an assortment of animal subjects.

Their studies of "rapid diagnostics," used to identify animal respiratory diseases before they attack and destroy entire herd or flock populations, may offer new preventive help to dairy and beef herdsmen, as well as the Delmarva broiler industry where losses to infectious bronchitis are estimated at nearly $6 million each year.

Making significant headway in identifying new viral strains which, in turn, have led to new antiviral vaccines, scientists have turned their research attention to investigating a new viral identification technique that holds promise for differentiating similar animal and human viruses. Virologists maintain that disease prevention and development of effective vaccines to treat newly emerging viral strains are critically dependent upon rapid identification of these variant strains.

Their "rapid diagnostics" typing method combines existing technology–a process called immunoenzyme assay, which rapidly measures infectious bronchitis antibodies in poultry flocks–with new project-developed monoclonal antibodies, capable of detecting minute differences between seemingly similar infectious viral strains. Perfected, the technique could accelerate viral diagnoses from a 2-week process to less than 20 minutes. These antibodies are a "cleaned, refined" version of infectious antibodies, achieved through a laboratory-induced cloning process.

This developing technique, used on some animal subjects to detect different look-alike viral strains, may be applicable to other animal species as new viral antegenic shifts occur. And researchers believe the technique, coupled with "flock serological profiling"–a Maryland research-developed method of identifying disease outbreaks before an entire herd or flock is decimated–could save cattle, horse and poultry businesses across the United States millions of dollars each year.

Quality Studies

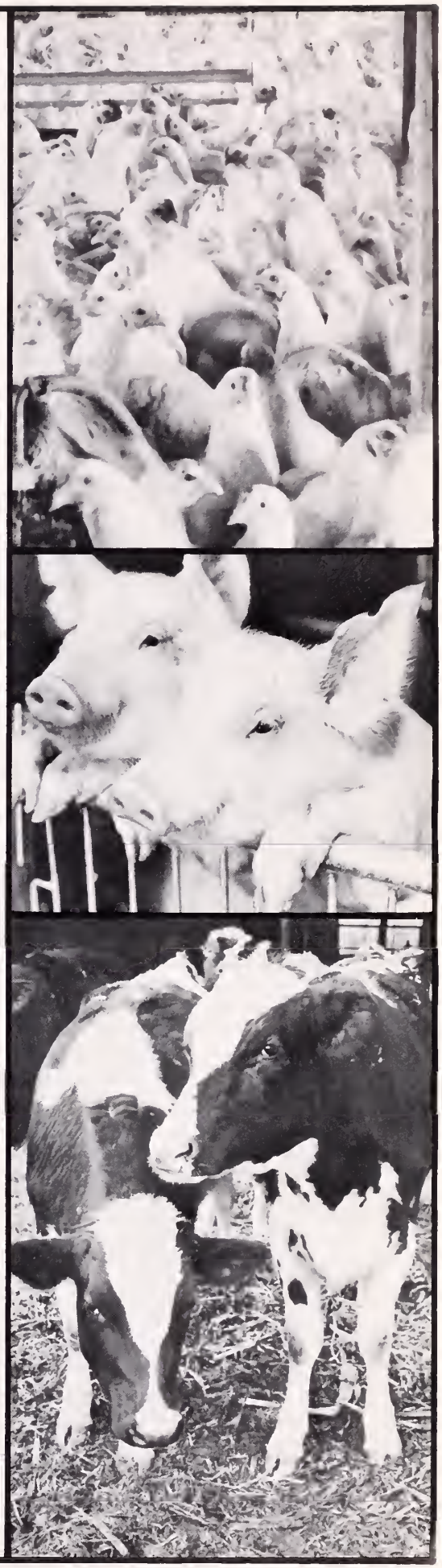
Research continues to invest efforts in studies to achieve higher levels of animal productivity, increased animal product quality and improved product processing technology.

Examples of these include poultry scientists' work with broiler quality and yield. Researchers there continue to grapple with a double-edged sword. Improved genetic selection has produced a large broiler that is marketable 7 weeks after hatching, with characteristics highly desired by both the industry's producers and consumers. However, the same genetic selection has introduced some undesirable traits such as lethargy that, in turn, increase the incidence of broiler carcass fat. Carcass fat is regarded by the industry as a waste disposal problem and inefficient use of feed. Consumers regard it as undesirable.

Researchers, therefore, continue to monitor new broiler crosses for undesirable traits so they will not become firmly established in the genetic line. In so doing, they have established a number of other study areas that will move them toward this goal. These include the relationship of nutrition and exercise with body fat; gathering updated information on optimum slaughter times to increase lean meat yields; new data on quality and yield of parts during the animal's withdrawal period from disease-preventive drugs before slaughter; and, establishing important guidelines for further automation in the poultry processing industry where increased efficiency and product uniformity are crucial keys to holding down production costs. This final area is important to restaurants, fast food operations and retailers who have shown interest in a highly uniform product that is most likely to come from continued processing line automation.

Poultry scientists also have conducted a number of studies relating to broiler and egg quality, reproductive vigor and diet.

They estimate that egg losses due to breakage can be cut in half as a result of studies contributing to an improvement of eggshell quality. Again, genetic selection offers an improved hen showing marked gains in egg production, but at a sacrifice. The modern



hen lays more and larger eggs within its productive lifetime, but that period of production has shortened. In exploring the relationships of nutritional, physiological and environmental factors with eggshell formation, researchers have found that laying hens' eggshell quality responds positively to the dietary incorporation of vitamin D metabolites. Furthermore, deficiencies in the hen's metabolism of this important vitamin D hormone appear to have a genetic component and such deficiencies may be assessable at a very young age. This would allow, say researchers, early selection by breeders for a layer's ability to produce strong shells.

Case Study–Mastitis Prevention

Bovine mastitis robs the American dairy farmer of an estimated $2 billion each year. Maryland's dairy farmers are not immune and in 1980 lost $24 million to this infectious bacterial disease through reduced milk production and treatment costs. Characterized by a national task force as one of the major problems facing the dairy industry, mastitis has become a number one research concern.

An economic and effective preventive measure for bovine mastitis appears to be the dairy industry's most realistic approach to mastitis, say researchers. Their research focuses, therefore, on the preventive approach and continues on two primary fronts through basic and applied studies.

Work is underway by dairy scientists to increase the limited store of knowledge available on the role of membranes in the milk secretion process and the dairy cow's natural immunity system. With studies designed to define the process at the cellular level, researchers are counting on information produced by their work to aid in the long-running battle against mastitis and other milk membrane-related diseases. In addition, there are direct implications for food production and quality since milk is considered a nearly perfect source of high quality protein for the consumer.

In their basic research studies, dairy scientists have discovered that bacteria-killing white cells (leucocytes) found in the dairy cow's mammary gland are less capable of combating disease than their white cell counterparts in the bloodstream. These same white cells play an important role in the cow's overall natural defense against mastitis. Studies indicate that mammary leucocytes manufacture less acid and do it more slowly than blood leucocytes, possibly inhibiting the disease-killing power of mammary leucocytes.

Other examples of basic mastitis research run across a broad range of studies, including those that characterize immunal systems in dairy cattle, determine how mastitis organisms invade mammary glands and discover methods of increasing natural resistance to mastitis.

A related and applied research study investigates full-scale production methods for so-called "monoclonal antibodies"–cloned, isolated organisms that are targeted for and attack a specific invading antigen such as the bacterial cells responsible for mastitis.

Another applied research study, using a small, inexpensive plastic loop called the IMD–or intramammary device–involves field tests here in Maryland. Studies are promising and indicate as much as a 44 percent reduction in the incidence of mastitis.

The principle of the IMD is quite simple, say researchers. Once inserted in the cow's udder it causes a mild irritation, triggering the release of white blood cells from the cow's natural immunal system. Leucocytes, in turn, attack and destroy the mastitis-producing organisms.

Use of the IMD, say researchers, causes no loss in quality or quantity of milk yield.

Vast stores of essential protein and nutrients for human consumption are contributed by livestock, poultry and their related food by-products, a significant part of agricultural production in Maryland.

Top—**Mastitis, the dairy industry's leading economic crippler, is studied under a broad range of projects, including applied research as shown here. Dairy scientists examine use of an intramammary device (IMD) that triggers the cow's natural immunity system against mastitis bacteria.**

Center—**Poultry scientists have contributed to increased broiler production in Maryland with studies of dietary effects on broiler nutrition, animal quality and yield.**

Bottom—**Veterinary scientists are working to develop superior breeds of animal livestock, perfecting such techniques as embryo transfer shown here. A superior breeding animal is "flushed" of fertilized ova, which are transferred to surrogate mothers who will carry the fetuses to term.**

Economics and Rural Life

As the face of rural America has changed, so have society's attitudes toward agriculture changed. At a time when all manner of natural and economic resources are in increasingly short supply, society's policymakers continue to request research information as they make decisions affecting agriculture.

Scientists from a number of disciplines are contributing to a variety of regional studies intended to provide state and federal decisionmakers with important policy information.

Rural Development Studies

Every day in this country, 4 square miles of prime farmland shift from agricultural production to nonfarm uses, according to a federal study. In Maryland, more than three-quarters of a million acres were lost between 1967 and 1977. Agricultural researchers continue to offer governmental bodies information outlining the costs of this loss to society, especially in the face of increasing population and food needs.

Economists have played a direct and continuing role in research's attempts to document farmland loss in Maryland. This research data generated a plan based on establishing an "agricultural-use" value indexed to return land to farm production, providing incentives for farmers to maintain land in agricultural uses. During 1981, agricultural economists worked actively with key state officials to update the use value formula and revise the use value bill to assure the needs of agriculture are met. Economists provided their research material to officials who used it to write legislation designed to tax farmland at this "agricultural-use" value, rather than its market value. Generally, "agricultural-use" value is less than market value and, for assessment purposes, benefits the Maryland farmer.

In late 1981 rural sociologists and economists began work identifying additional social and economic implications of farmland use and conversion to nonfarm uses.

Economic Analysis

Record levels of drought during the 1980-1981 winter have prompted Maryland farmers to begin looking anew at irrigation. This renewed interest, however, raises some economic questions about conflicts between agricultural and other water users.

Agricultural economists began studies in late 1981 to determine the potential costs and benefits of irrigation expansion in Maryland and other Middle Atlantic States. Their initial emphasis was on Maryland's Eastern Shore where they forecasted the water demand for irrigation and planned to compare that with other demands for water.

While incentives to invest in irrigation equipment created by 1980-81's drought are likely to be temporary, economists believe their studies will show several long-run forces are likely to remain. Some of the factors they will be considering are: Improved, labor-saving irrigation equipment continues to be developed; the upward pressure of farm product prices because of increased food demands continues; farmers are increasingly vulnerable to the economic threat accompanying drought; and most important, increasing evidence indicates that many crops and cropping systems can be grown more profitably with irrigation.

Research data available now, in fact, show that in areas similar to Maryland's Eastern Shore the net gain per acre from irrigation can range from a low of $16 for soybeans to a high of $378 for cucumbers. Clearly, investment in irrigation equipment can be profitable for some crops, say economists, and the return may be higher for certain double-cropping patterns. Their continuing investigation should provide valuable information to producers who must balance the increased costs of irrigation with a potential loss of farm income during drought periods.

Still, the potential for conflict among water users exists, according to researchers who are developing economic models to measure trade-offs between agriculture and other users of water. In addition to identifying competing interests, economists plan to examine institutional arrangements that could provide efficient and equitable allocation of water resources during periods when annual claims exceed annual replenishment.

Youth Development in Agriculture

One of agriculture's greatest single resources is people. Research on the development and administration of programs continues to provide information aiding others to fashion youth for leadership roles and successful careers in agriculture.

Enrollment in vocational agriculture in the nation's secondary public schools peaked in 1976-1977 at nearly 700,000. In that same year, 73 percent of those enrolled in vocational agriculture were members of the Future Farmers of America (FFA), the vocational youth organization for agriculture students, and FFA membership reached an all-time high of over a half-million members. The Eastern Region of the FFA mirrored the national statistics.

A subsequent downturn in membership, however, triggered Maryland research, in cooperation with the national FFA in the 15-state Eastern Region, to evaluate possible explanations often associated with declining memberships. Results of those studies indicate the membership drop was not related to the certification status of teachers, change in length of teacher contracts, the shortage of vocational agriculture teachers or the cost of FFA membership.

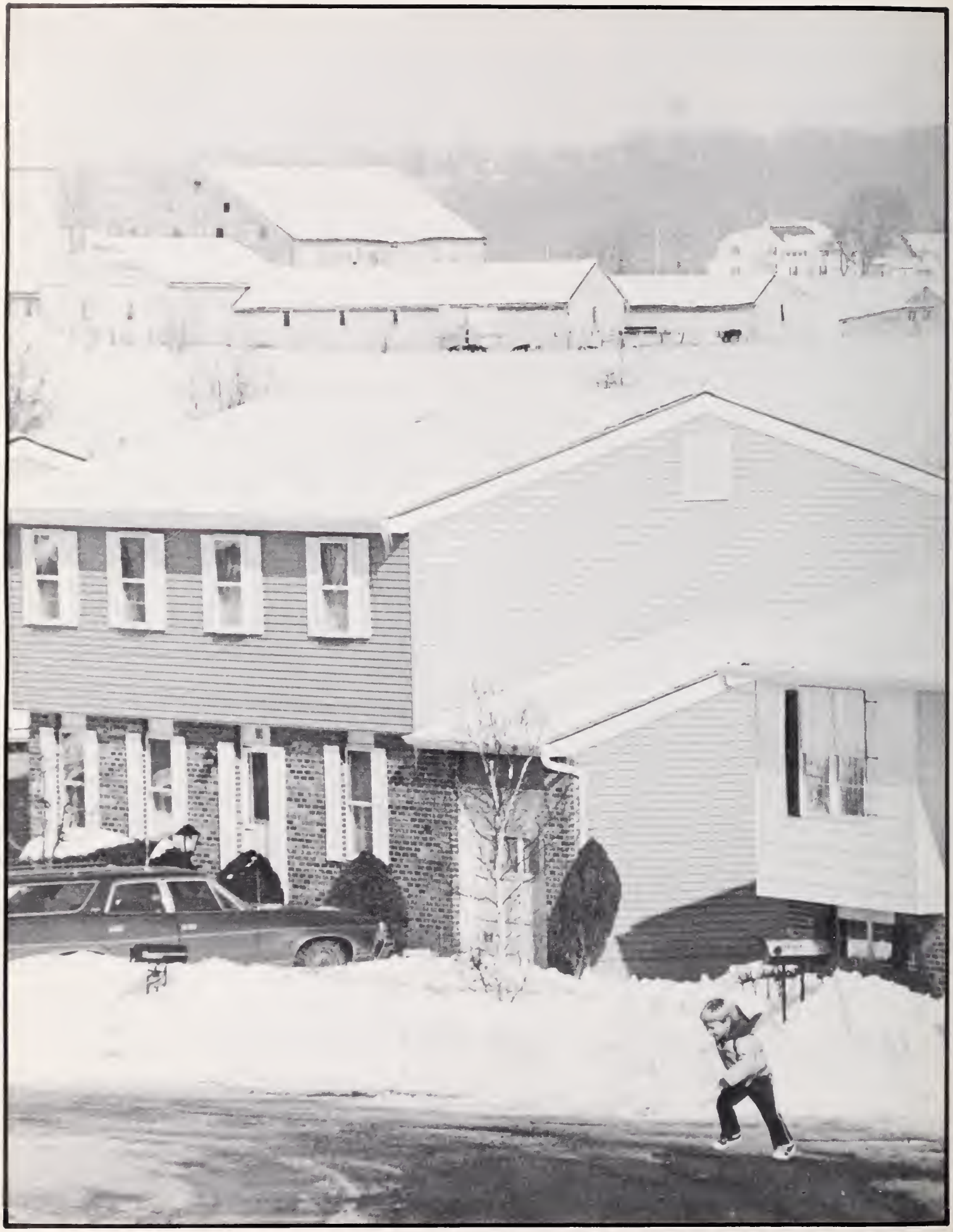
While Maryland has maintained stability in the number of vocational agriculture programs and FFA chapters in recent years, considerable change was observed in several other states in the Eastern Region. Some states lost as much as 14 percent of their FFA chapters while others gained as much as 10 percent over a 3-year span. Additional research efforts should determine why education in agriculture is not available in many school districts in the United States. Some authorities report that 49 out of 50 major U.S. cities have some type of vocational agriculture and studies indicate a continuing need to place high quality vocational agriculture programs within reach of all high school youth who plan careers in agriculture.

Maryland Fisheries Resources

Each year, the vast natural resources stocks of the Chesapeake Bay and Maryland's off-shore waters provide income, employment and recreational opportunities for many of the state's citizens. In 1980, nearly $50 million in fishery products were landed in Maryland.

In addition, sport fishermen during 1980 were estimated to have taken 3.5 million sport fishing trips in Maryland and spent nearly $100 million on recreational fishing. These commercial and recreational activities derived from the Chesapeake Bay are an essential part of the Maryland economy.

These resources, however, are coming under increasing threats from expanding population and economic activity. Growth and increased population demand for food and recreational activities have placed substantial pressure on resources such as crabs, striped bass, surf clams and oysters.



Addressing these concerns are agricultural economists who have studied the legal and economic consideration of management methods used by Maryland to regulate fisheries harvest, particular complications such as the migratory nature of the aquatic species involved, and the question of dealing with these problems on a regional or national basis.

Economists also have examined the effects of water pollution on consumer purchases and on the earnings of fishermen. Additionally, they are investigating impacts on local economies of reduced harvests of striped bass and are coordinating research efforts to measure the value of sport fishing in Maryland.

Case Study–A Changing Rural Face

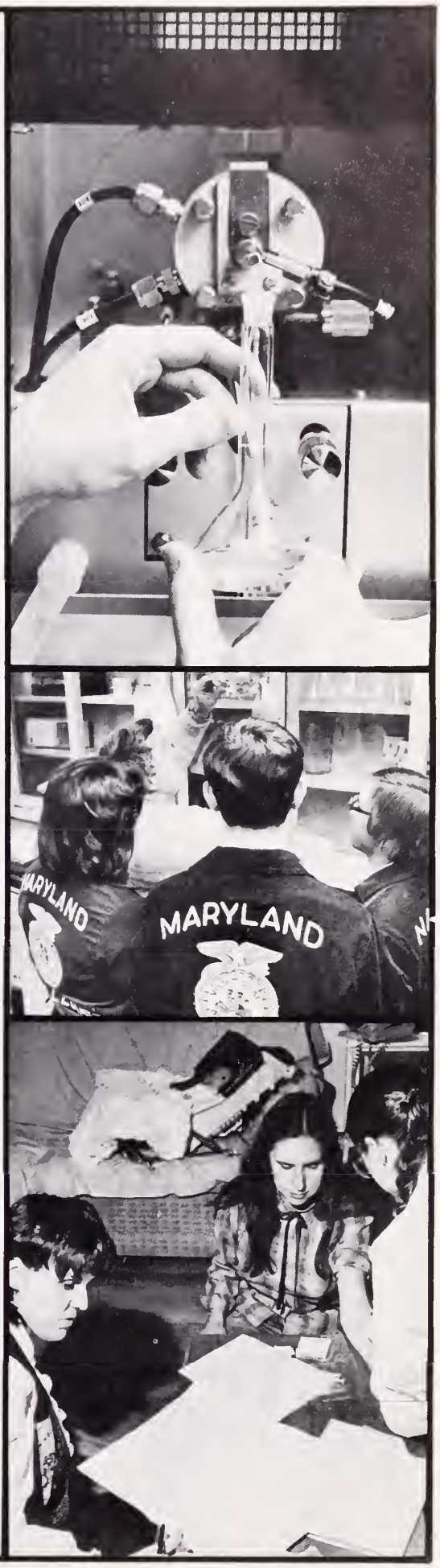
Population migration, historically, has been from rural to urban areas until the 1960s when a new distribution pattern–the exact opposite of its predecessor–emerged. This pattern of general population flow from metropolitan to nonmetropolitan areas since then has remained entrenched, and it appears it will continue, note researchers.

Maryland researchers have been engaged in lengthy studies of the impact of this reverse flow on agricultural and nonmetropolitan communities throughout the U.S. Northeast. The magnitude and impact of these recent population shifts, as well as the forces causing them, are being documented now to provide policymakers at local, state and federal levels with future information they will need as they respond to the changing characteristics of northeastern communities and people.

Rural sociologists have identified and defined a deconcentration of the labor force in the U.S. Northeast that parallels the general population shift from metropolitan to nonmetropolitan areas. Researchers have found several factors at work in this process: The number of people identified as members of the U.S. labor force and the number moving out of metropolitan areas have increased; the number of labor force members moving out of the nonmetropolitan areas has declined; and more labor force migrants from metropolitan areas are showing a preference for nonmetropolitan areas for their new place of residence rather than another metropolitan area.

Researchers, however, have gone beyond this limited documentation and demonstrated that a distinction should be made between two very different types of population movement: That movement occurring within the confines of a metropolitan region composed of a central city, suburban areas surrounding the central city and a zone outlying rural territory, such as the "heartland to the hinterland" movement; and, that movement occurring from one metropolitan region to another. The distinction is critical, researchers have found, because their data suggest that the recent labor force migration trends have been largely due to movement between metropolitan regions and not centrifugal, or within region movement, as might otherwise have been anticipated. Large metropolitan areas were particularly affected by this migratory pattern, experiencing relatively high net rates of outmigration for the 1970 to 1975 period. Lesser metropolitan and nonmetropolitan areas, on the other hand, were beneficiaries of the new migration pattern, experiencing net labor force gains after an historical pattern of loss. And small metropolitan areas, the data suggest, are closely in line with their medium metropolitan counterparts.

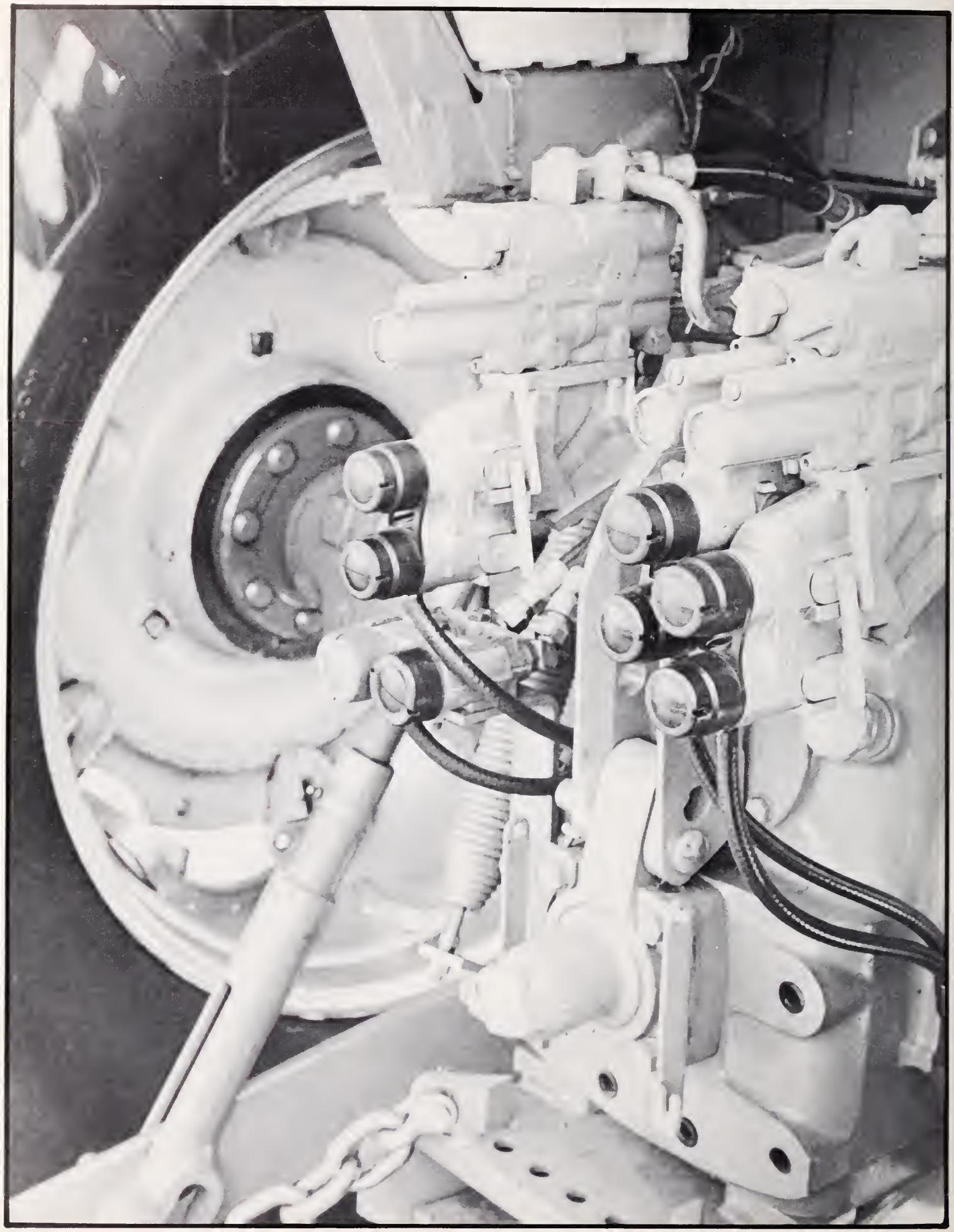
Researchers note that some rather interesting questions arise from their findings. For example, what changes in the geographic structure of the American labor market, and the demand for labor in particular, have produced these results? And, what are the implications of these findings for the more general population turnaround? The answers to these questions are the subjects of further research.



Urban encroachment on prime farmland is on the rise across the United States and in Maryland. Agricultural economists and rural sociologists are assessing the impact of farmland conversion in Maryland on farm productivity, social services and the rural environment.

Center—**One of agriculture's most valuable resources—and its hope for the future—is youth. Researchers in agricultural education investigate reasons for declining memberships in such vocational-oriented organizations as the Future Farmers of America.**

Top and bottom—**Nutrition experts survey the vitamin and mineral needs of rural pregnant and lactating mothers. Samples of mothers' milk, hair and blood are analyzed for their zinc and other mineral content.**



General Resource Technology

Much of day-to-day agricultural research is dedicated to gaining a clear understanding of how and why our world functions as it does. General resource technology, in turn, takes that information and decides how best to put it directly to work for agriculture and its consumers. At the Maryland Agricultural Experiment Station, technological research advances keep pace with the contributions of basic research in a cooperative effort, providing continuity from basic research hypothesis, through experimentation to, finally, the consumer.

Product Development

Sterile milk development is a model of cooperation between three research disciplines and has received widespread popular, as well as scientific, attention.

During the years 1973 and 1974–popularly known as the advent of the "energy crunch"–consumers and industries alike suddenly became energy conscious, and the notion that milk could be treated in some manner other than pasteurization–remaining unrefrigerated during transport and storage for long periods of time–aroused more than academic interest. The marketing arm of the milk producing industry, in particular, saw sterile milk development as a potential and significant energy-saving breakthrough.

Since research already had designed the parameters for treating milk by sterilization, it remained for others to find the right technique that would make sterile milk palatable to consumers who objected to the "cooked flavor" of earlier attempts. Agricultural engineers worked with dairy scientists on a significantly different sterile milk processing technique, using ultra-high temperatures to destroy living microorganisms, which did not produce the objectionable aftertaste.

Their cooperative work continues on an infusion process that injects saturated steam instantaneously into the raw milk, raising its temperature to as high as 300°F for a very short period of time–4 or 5 seconds. Immediately afterward, the milk is flashed through a vacuum where the sudden pressure and temperature drop causes it to vaporize, removing all accumulated heat and moisture gained during the infusion process. Packaged properly, the resulting product can be transported and stored, unrefrigerated for approximately 6 weeks.

This infusion technique, however, is not limited to milk. Anything that flows and requires sterilization–such as fruit juices, soups and pharmaceuticals–is applicable to this process. Scientists and economists believe its applications are far-reaching. Non-dairy areas of the country and the world, for the first time, can have ready access to treated, whole milk. The military no longer will have to depend on refrigeration in remote areas to keep whole milk, and significant savings in energy costs can be enjoyed by the milk producing industry and consumers.

Additionally, agricultural economists have outlined for the dairy industry economic factors that must be taken into consideration before dairy and allied industries are likely to accept sterile milk.

For example, researchers maintain that sterile milk could accelerate the existing trend to larger, centralized dairy plants. These plants, with their wider distributing areas, would be more likely to support sterile milk than smaller, local dairies.

In addition, they say, sterile milk introduction will require substantial capital investment. This will have more impact on new dairy plants than older plants where equipment may be fully or nearly depreciated.

Other economic considerations, say researchers, include the possibility that sterile milk will be more expensive at the outset for consumers to purchase than pasteurized milk because of initial capital investment costs. Labor requirements, they add, may decline in the dairy processing industry because of shifts in skills, increased efficiency in new handling systems and less frequent deliveries as milk is warehoused and handled like other less perishable food products.

Energy Technology

Most experts agree, the world's energy supply has been taxed heavily in the last few years. Unless measures are taken to find new energy sources and increase energy-use efficiency, they say, everyone will face grave consequences. Agricultural research and the family farm operation may hold part of the solution. In fact, animal production operations in Maryland, with the vast amounts of organic residue they generate, could offer a solution to problems of producing additional energy and disposing of waste.

Agricultural engineers now at work on studies of dairy farm waste digestion systems believe their experimental system can contribute a portion of the energy needed to heat a farmer's house, power farm equipment, provide fuel for both electric generators and cooking needs, all from materials available on the farm. At the same time, the manure from a typical 60-head dairy operation feeding this suggested system would emerge, ultimately, as odorless fertilizer.

The system under experimental study accepts concentrated manure from a 700-head dairy operation. The digester is a covered 680-cubic-meter pit, allowing an equal amount of digested material to exit the system as new manure is pumped in. Heat exchangers keep the temperature at an ideal 35°C as bacteria break down the manure, forming biogas that expands the pit's rubber bag cover like a ballon.

Engineers have tapped and used the biogas as fuel for an engine powering an electric generator. Additionally, the manure exiting from the digester after bacteria treatment is virtually odorless, and both volume and acidity are reduced.

Researchers continue to monitor the digester's efficiency, the system generator's fuel consumption and its electricity production capability. Also, their investigation includes evaluation of the heating potential of the system's biogas and evaluation of effluent quality from the digester system.

Expanding Farming's Horizons

What agriculture traditionally has been to the land, aquaculture has become to large bodies of water such as Maryland's Chesapeake Bay and the state's coastal waterway. There, researchers believe the rapidly growing interest in water-based animal and plant production for human consumption can flourish side-by-side with other competing interests like recreation and industry.

Aquaculture, however, suffers like any other new scientific frontier from a lack of basic research information, primarily about water farm production systems. It makes aquaculture, in spite of its potential attributes, a still risky investment today.

Recognizing the importance and potential of aquaculture to Maryland, researchers are investigating a unique approach called the "closed cycle culture system," in which an area set off for production functions much like a world unto itself.

A self-contained, self-sustaining ecosystem, the closed cycle culture approach is a small-scale version of larger ecosystems such as the Chesapeake Bay, or Earth for that matter. Plants and animals within the system live off of each other–the plants producing oxygen and food for animal life; the animals' wastes producing carbon dioxide and fertilizer for the plant life.

Scientists have taken this approach one important step further. They are experimenting with the introduction of "biological filters" to balance the entrance of such foreign materials into the system as pollutants from nearby industry, or runoff from farmland. Development of such biological filters would add immensely to research's efforts to move aquaculture from hypothesis to reality. But, in addition, its immediate spinoff–contributing to an understanding of how toxic substances affect an environment–may bring us much closer to increasing food production in bodies of water such as the Chesapeake Bay.

Another aquaculture study is underway at the University of Maryland-Eastern Shore (UMES). There, mariculturists are investigating the market potential for the Atlantic rock crab, an edible, underutilized ocean species.

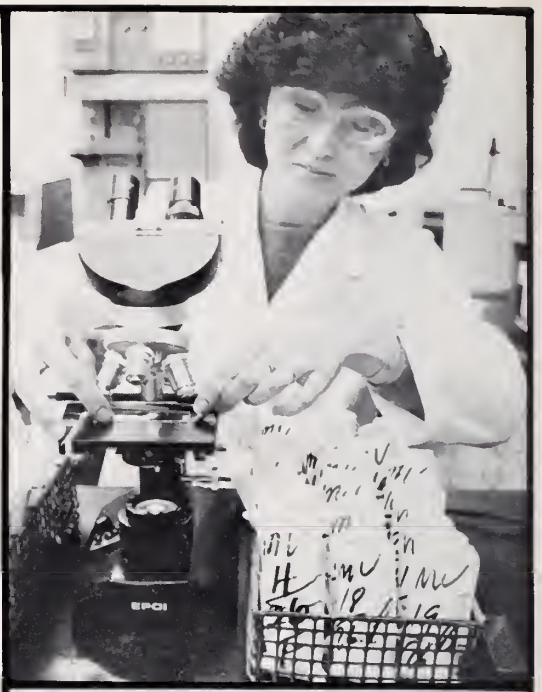
Research includes scientists' attempts to manipulate the biological rhythms of the crab which, in turn, may lead researchers to methods of producing more winter soft crabs than would be possible in the crab's natural environment.

Researchers also have undertaken studies of the species' patterns of movement and reproductive activity. This information, they say, may be used to direct commercial crabbers to ideal harvest locations year round without capturing females laden with eggs, thus protecting reproduction of the species.

Finally, mariculturists at UMES are engaged in studies that have determined nutritional requirements for rock crab, its molting patterns and marketing surveys that indicate acceptance of rock crab by restaurateurs and diners. This final information is important as prices for the now-abundant Maryland blue crab climb and areas of the Eastern Seaboard–where the blue crab is not abundant–seek readily available crabmeat from other sources.

Case Study–Moving Toward Energy Efficiency

The long lines at the fuel pumps in 1973-74 may be a dim memory for some, but they sparked a flurry of research interest in alternate fuel sources that continues unabated today. All of the activity, however, has not been limited to the research and develop-



Applied technology studies are instrumental in elevating the state of the art of today's mechanized farming. Engineers, working in cooperation with various other agriculture-related disciplines, are turning their attention now to improved dairy processing methods, reduced energy consumption and the search for alternate energy sources for tomorrow's farm.

Top left—**Improved processing methods for sterile milk production resulted from cooperative efforts of economists, engineers and dairy scientists.**

Center—**Engineers experiment with on-farm digestion systems that process manure into biogas fuel and produce odorless fertilizer as a by-product for the farm of tomorrow.**

Bottom—**Laboratory experiments analyzing the quality of water in biological filtration systems lay the groundwork for future commercial efforts in aquaculture—the controlled cultivation, management and harvest of food products from the sea.**

Below—**One underutilized sea species found nearby off Maryland's coast is this Jonah crab (Cancer borealis), a 7-year-old test subject at the University of Maryland-Eastern Shore research center. There, mariculturists believe manipulating the crab's biological rhythms may provide a viable winter soft crab industry in Maryland.**

ment laboratories of the major oil companies. Much is taking place now at agricultural experiment stations across the country.

Maryland researchers competed nationally for and received a federal grant in 1981 to explore alternate fuel uses. Researchers from several disciplines plan to apply modern technology to basic agricultural practices, enabling a farmer to grow and produce part of his own fuel side-by-side with the same crops that feed his livestock.

That notion is not as far-fetched as some may believe. Vegetable oils from a variety of common crops may be used as an "extender" to diesel fuel in much the same manner as corn-produced alcohol is used to extend gasoline as "gasohol." The key to this research, however, is its reciprocating nature. The raw materials needed for diesel extenders would be part of tomorrow's farm, and the production by-products could be used as livestock feed, scientists say.

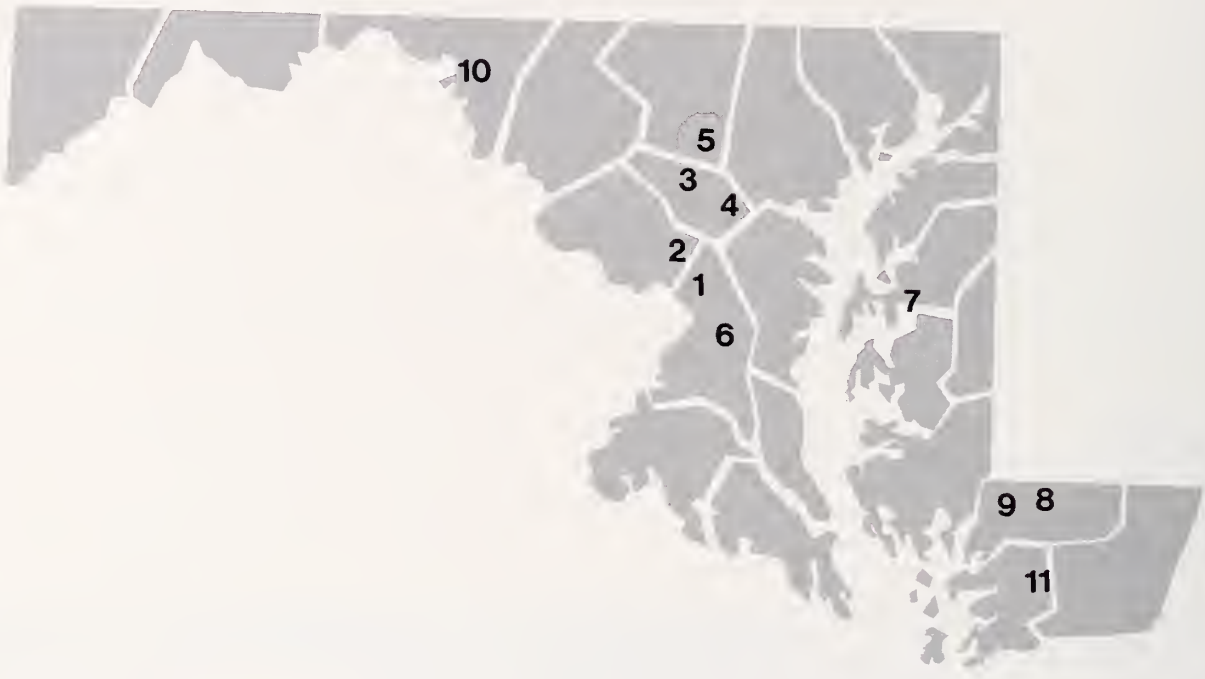
In this study, agronomists are examining various crop combinations of peanuts, soybeans, sunflowers, rapeseed and winter wheat to determine which produce the quality and quantity of vegetable oil best suited to extending diesel fuel.

Agricultural engineers, meanwhile, are developing the equipment that will produce vegetable oil from these crops, and conducting engine tests with oil-diesel combinations to determine optimum performance mixes. Simultaneously, animal scientists are studying the possible use of vegetable oil production by-products as swine and sheep feed supplements.

Agricultural economists are studying the cost and energy feasibility of this self-sufficiency model for tomorrow's farm.

The results could be of immense significance to American agriculture. Although today's farm equipment is approximately 53 percent diesel-powered, that figure is expected to shoot up to 88 percent by 1990.

Maryland's Research Farms



With a blend of basic and applied research, Maryland Agricultural Experiment Station scientists provide a continuing flow of new knowledge essential to the solution of the practical problems facing farmers today. The Experiment Station carries out its research programs at field stations located across the state, reflecting the regional differences of Maryland farming.

Visitors are welcome at the experiment station research centers. In some instances, visits to facilities are restricted because of requirements of specific research projects. Interested parties should contact the research center directly to set up a meeting or for specific information on location and hours of operation.

1 2 3 4 5 6 7 8 9 10 11

University of Maryland College Park
MAES Headquarters (301) 454-3707
Research work in all phases of agriculture and related fields.

Plant Research Farm (Montgomery county)
Research on turfgrass, insects, truck crops and small fruit. 318 acres. (301) 572-7247–Agronomy; (301) 572-5339–Horticulture.

Agronomy–Dairy Forage Farm (Howard county)
Studies of dairy nutrition and management and pollution abatement practices. 922 acres. (301) 286-3211.

Horse Research Center (Howard county)
Research on physiology, nutrition and management of horses. 154 acres. (301) 465-3760.

Beef Research Center (Carroll county)
Research concerning livestock production and management. 715 acres. (301) 795-1310.

Tobacco Research Farm (Prince George's county)
Research relating to tobacco breeding, production, harvesting and curing. 206 acres. (301) 627-3273.

Wye Research Center (Queen Anne's county)
Work on plant breeding, weed and disease control, and production systems for corn, soybeans, vegetables and ornamentals. 123 acres. Additional research in cooperation with Wye Institute. 355 acres. Work with Wye Angus herd. Approximately 475 acres on Wye Plantation. (301) 827-6202–Center Headquarters.

Salisbury Research Substation (Wicomico county)
Experimental studies dealing with poultry and breeding, insect, pest and disease control, production systems and management and processing of vegetable crops. 89 acres. (301) 742-8788–Horticulture; (301) 749-9539–Poultry Science.

Poplar Hill Research Farm (Wicomico county)
Studies of disease control, breeding, pest control and production systems for corn, soybeans and vegetable crops. 166 acres. (301) 742-9694.

Sharpsburg Research and Education Center (Washington county)
Research on fruits, vegetables, ornamentals, field crops, soils and disease and insect control. 546 acres. (301) 791-2298.

University of Maryland Eastern Shore
MAES 1890 Agricultural Research Program
Research work in human nutrition, pest control and cultural practices for soybeans and corn, small farm development, child development. (301) 651-1598.

Financial Statement 1980-81

Expenditures by Major Research Program Areas

	Percentage	Amount
Natural Resources & Forestry	12	$ 830,915
Plants & Crops	40	2,769,718
Animals & Poultry	30	2,077,288
Economics & Rural Life	13	900,158
General Resource Technology	5	346,215
TOTAL	100	$6,924,294

Sources of Income (State FY 1981)

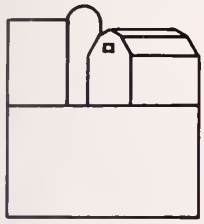
State Appropriations	$4,573,666
Farm Sales	371,072
Federal Funds	
Hatch Formula Funds	1,313,405
Hatch Regional Research Funds	461,093
McIntire-Stennis (Cooperative Forestry Research) Funds	109,231
Animal Health, Sec. 1433 Funds	91,104
Rural Development - Title V Funds	4,723
TOTAL ALL FUNDS	$6,924,294

Scientific Articles and Publications 1980-1981

The Maryland Agricultural Experiment Station was established to develop, conduct and disseminate research information. This knowledge is communicated to the agricultural community through Experiment Station miscellaneous publications and bulletins which reflect research findings. Experiment Station scientists frequently submit scientific articles to various professional journals. These articles reflect the Maryland Agricultural Experiment Station's reputation for research excellence.

The following section lists scientific articles and miscellaneous publications for 1980-81. Publications will be mailed free to all residents of the state who request them. Please address all requests to:

Agricultural Duplicating Services
2900 52nd Avenue
Hyattsville, MD 20781



Agricultural and Extension Education

Scientific Articles

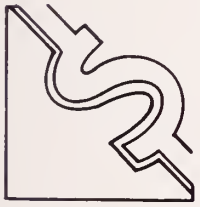
A Study of FFA Membership Trends and Their Relationships to Selected Variables. E. L. Cooper, R. Arrington, III, K. M. Maxwell, C. L. Nelson. Presented at the Eastern Regional Research Conference of American Association of Teacher Educators in Agriculture. **A2982**

Two Methodological Approaches to Recreational Substitutability. J. J. Vaske, M. P. Donnelly. Presented at the annual meeting of the Rural Sociological Society, Guelph, Ontario. **A3000**

Similarity Judgments in Substitutability Research. J. J. Vaske, M. P. Donnelly, D. L. Tweed. Presented at the 1981 Southeastern Recreation Researcher's Conference, Asheville, NC, February 1981. **A3004**

Miscellaneous Publications

Turkey Hunters in Maryland–A Comparison with Hunters and Fishermen in the Midwest. M. P. Donnelly, J. J. Vaske. **955**



Agricultural and Resource Economics

Scientific Articles

Comment: Valuing Congested Recreation Sites, K. E. McConnell. **Journal of Environmental Economics and Management.** **A2890**

Some Economic Aspects of Managing Marine Recreational Fishing. K. E. McConnell, I. E. Strand, Jr. Presented at University of Delaware–"Economic Analysis in Fisheries Management Plans" and chapter in a book (title unknown). **A2904**

Competition for Farmland (A Case Study of Frederick County, Maryland). S. Ishee Northeast Regional Center for Rural Development, Ithaca, NY. **A2938**

An Investigation of the Effect of Monetary Factors on Agriculture. R. G. Chambers, R. E. Just. **Journal of Monetary Economics.** **A2939**

Optimal Production Pattern for a Representative Farm Under Alternative Base-Excess Seasonal Milk Pricing Plan. A. M. Prindle, J. S. Livezey. **Journal of the Northeastern Agricultural Economics Council.** **A2940**

Theory and Estimation of the Household Production Function for Wildlife Recreation. N. E. Bockstael, K. E. McConnell. **Journal of Environmental Economics and Management.** — A2954

A Model for Planning Timber Production with Evolving Prices and Costs. K. E. McConnell, J. N. Daberkow, J. W. Hardie. **Journal of Environmental Economics and Management.** — A2960

An Analysis of Participation in Nonconsumptive Wildlife Recreation: Reply. M. J. Hay, K. E. McConnell. **Land Economics.** — A2967

Duality, the Output Effect and Applied Comparative Statistics. R. G. Chambers. **American Journal of Agricultural Economics.** — A2988

Theoretical and Empirical Considerations for Price Margins: An Application to the Striped Bass Market. J. E. Strand, Jr., R. G. Chambers. Contribution to NE Regional Project 128. — A3017

Interrelationships Between Monetary Instruments and Agricultural Commodity Trade. R. G. Chambers. **American Journal of Agricultural Economics.** — A3025

Miscellaneous Publications

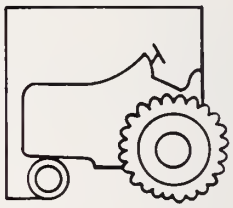
Risk Analysis and Optimum Crop Combination Plans for Small Farmers in the Somerset and Wicomico Counties of Maryland. I. Ahmad. — 952

Alternative Fuel for the Early 1980's: Gasohol. B. V. Lessley, J. E. Strand, Jr. — 962

Costs and Returns of Maryland's Standardbred Breeders. R. G. Lawrence, J. M. Downes. — 963

Comparative Costs and Relative Efficiency of the Delmarva Broiler Industry in Interregional Competition. J. E. Via, J. L. Crothers. — 966

Agricultural Engineering



Scientific Articles

Design, Evaluation and Effluent Water Quality Analysis of Three Oyster Shellstock Washers. S. C. Chang, F. W. Wheaton. Transactions of American Society of Agricultural Engineers, 1981. — A2614

Housing Designs for Efficient Livestock Production and Reduced Pest and Disease Problems. R. G. Yeck. Proceedings of the symposium "Systems Approach to Animal Health and Production". — A2963

Preservation of Aquacultural Products. F. W. Wheaton, T. B. Lawson. Presented at the 1981 Summer Meeting of the American Society of Agricultural Engineers. — A2992

Prediction of Minimum Exhalation Time from Resting Pulmonary Function Tests. A. T. Johnson, C. O. Dotson, M. Caprarola, V. C. Thomas. **American Industrial Hygiene Association Journal.** — A2995

Watershed Instrumentation Problems. M. Yaramanoglu, G. K. Felton, L. Wanchoo, T. B. Lawson. Presented at the 1981 Summer Meeting of the American Society of Agricultural Engineers. — A2996

Nonpoint Pollution from Various Agricultural Land Uses. T. B. Lawson, M. Yaramanoglu, G. McClung, D. S. Glenn. Presented at the 1981 Summer Meeting of the American Society of Agricultural Engineers. — A2997

Gas Exchange: A Technique for Extending Shelf Life of Foods. F. W. Wheaton, A. Kramer, Y. Lotem. Proceedings of the Modified and Controlled Atmosphere Packaging of Seafood Products Conference, January 1981. — A3013

Airflow Perturbation Device for Measuring Airways Resistance of Animals. A. T. Johnson, C-S Lin. Transactions of American Society of Agricultural Engineers. — A3027

Airways Resistance of Conscious Boars. A. T. Johnson, C-S Lin. **Respiratory Physiology.** — A3033

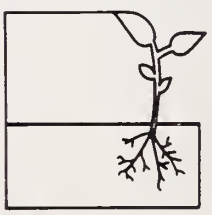
Airflow Perturbation Device for Measuring Airways Resistance of Humans and Animals. A. T. Johnson, C-S Lin. IEEE Transactions on Biomedical Engineering. — A3034

Model Analysis of Airflow Perturbation Device. A. T. Johnson, C-S Lin. **Biomedical Computing.** — A3041

Miscellaneous Publications

Spray Irrigation of Domestic Sewage Effluent on Atlantic Coastal Plain Soils and Vegetation: The St. Charles City Wastewater Irrigation Project. J. E. Ayars, L. C. Athanas. — 964

Agronomy



Scientific Articles

The Effect of Rate on Goosegrass Control in Fairway Turf Using Preemergent Herbicides. J. K. Mathias, P. H. Dernoeden. Proceedings of the Northeast Weed Science Society Meeting. — A2893

Single versus Repeat Application of Various Herbicides for Crabgrass Control. P. H. Dernoeden, J. K. Mathias. Proceedings of the Northeast Weed Science Society Meeting. — A2894

Effrcts of Excessivr Levrls of Some Postemrrgent Crabgrass Hrrbicides on Tnfeote Brrmudagrnss and Penncross Crerping Bentgrass. P. H. Dernoeden, A. S. Nash. Proceedings of the Northeast Weed Science Society Meeting. A2895

Effects of Reapplication of Growth Retardants in a Two Yrar Study on Kentucky Blurgrass. P. H. Dernoeden, J. K. Mathias. Proceedings of the Northeast Weed Science Society Meeting. A2896

Nitrogen Fixation Ratrs of Alfalfa and Red Clovrr Grown in Mixture with Grasses. L. de Anda Craig, W. J. Wiebold, M. S. McIntosh. **Agronomy Journal.** A2897

Summrr Control of White Clover Using Low Rates of 2, 4-DP (OSA) in Combination with Other Herbicides. D. D. Minner, P. H. Dernoeden. Proceedings of the Northeast Weed Science Society Meeting. A2898

Environmental Influrnce on Weather Fleck Ratings for Maryland Tobacco Cultivars. M. K. Aycock, Jr. **Crop Science.** A2907

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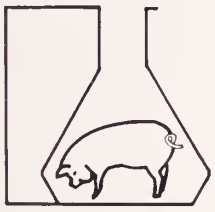

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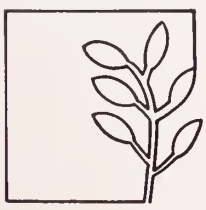

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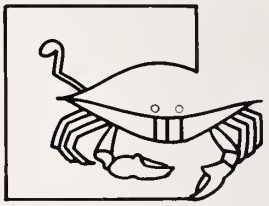

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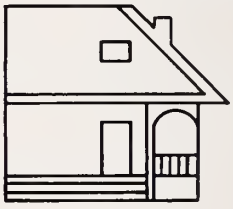

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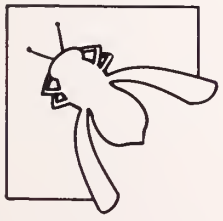

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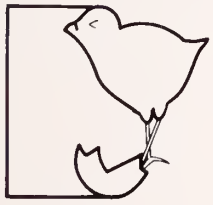

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